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(54) Security bolt and spanner

(54) A wrench for engaging a fastener 82 comprising a base 30, a plurality of retaining elements 60 mounted on the base and corresponding in their distribution and orientation to a plurality of spaced sockets 20 formed on a semispherical head of the fastener 1. The spanner comprises a sleeve 70 operative in a first position to allow the retaining elements 60 to adopt first retracted positions wherein ready engagement or disengagement of the spanner with the fastener head is permitted, and being operative in a second position to urge the retaining elements 60 into second extended positions whereby the fastener head is securely retained in engagement with the spanner by the retaining elements and both separation and relative rotation between the spanner and the fastener is prevented.

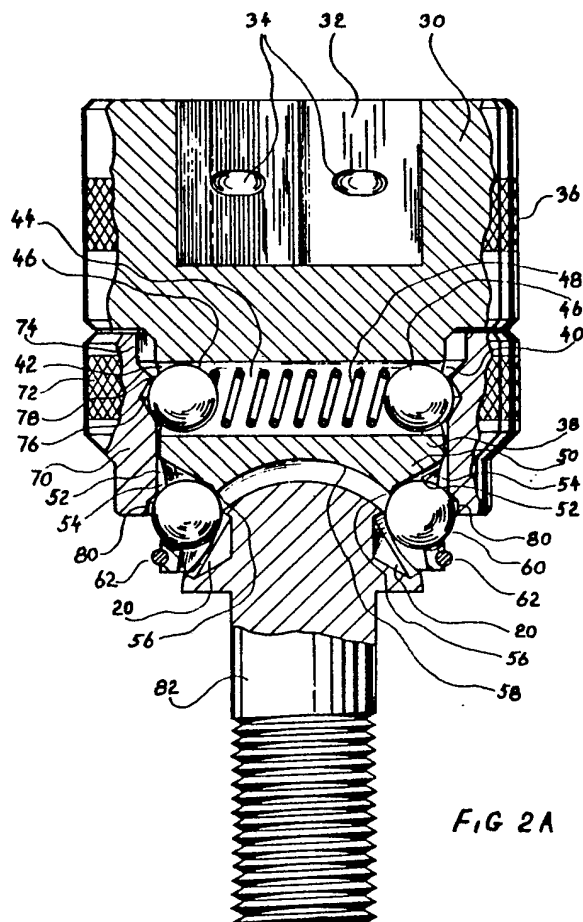
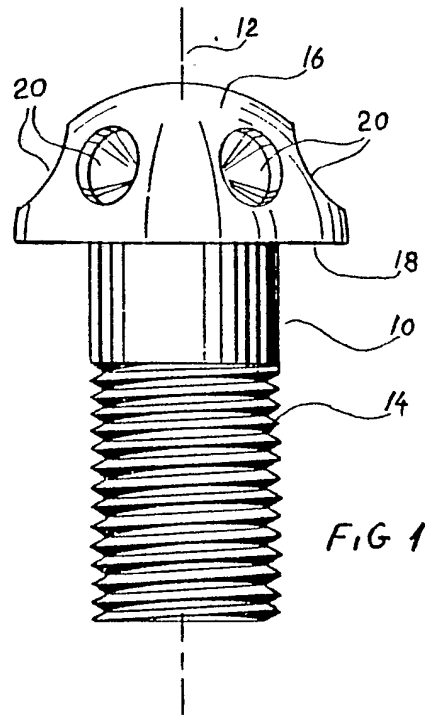
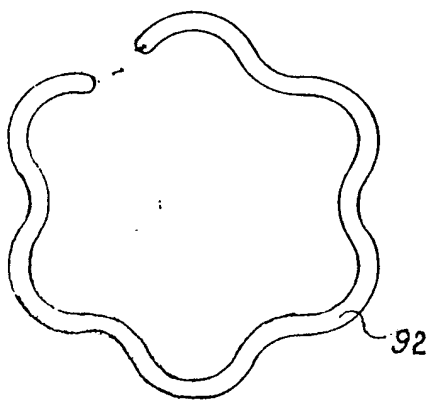
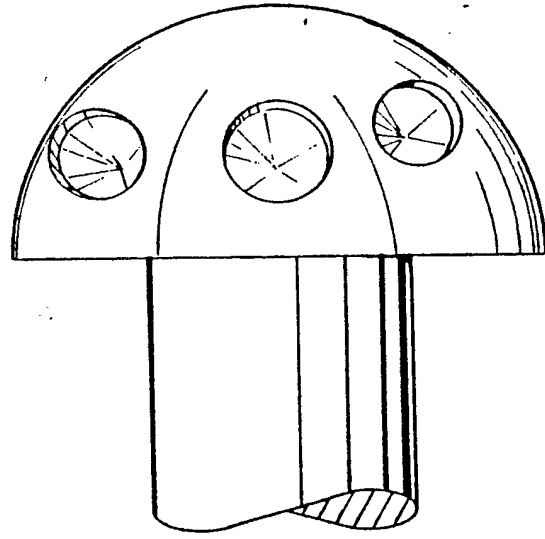
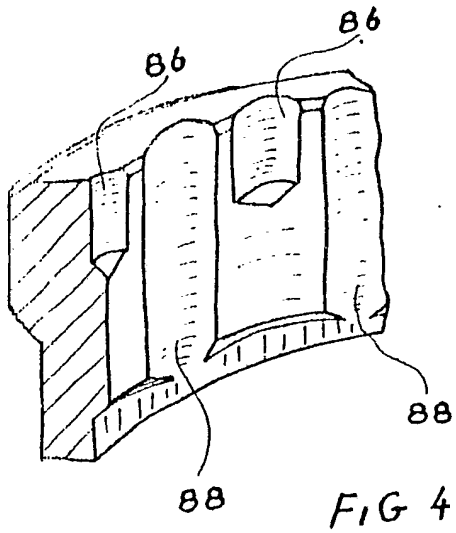
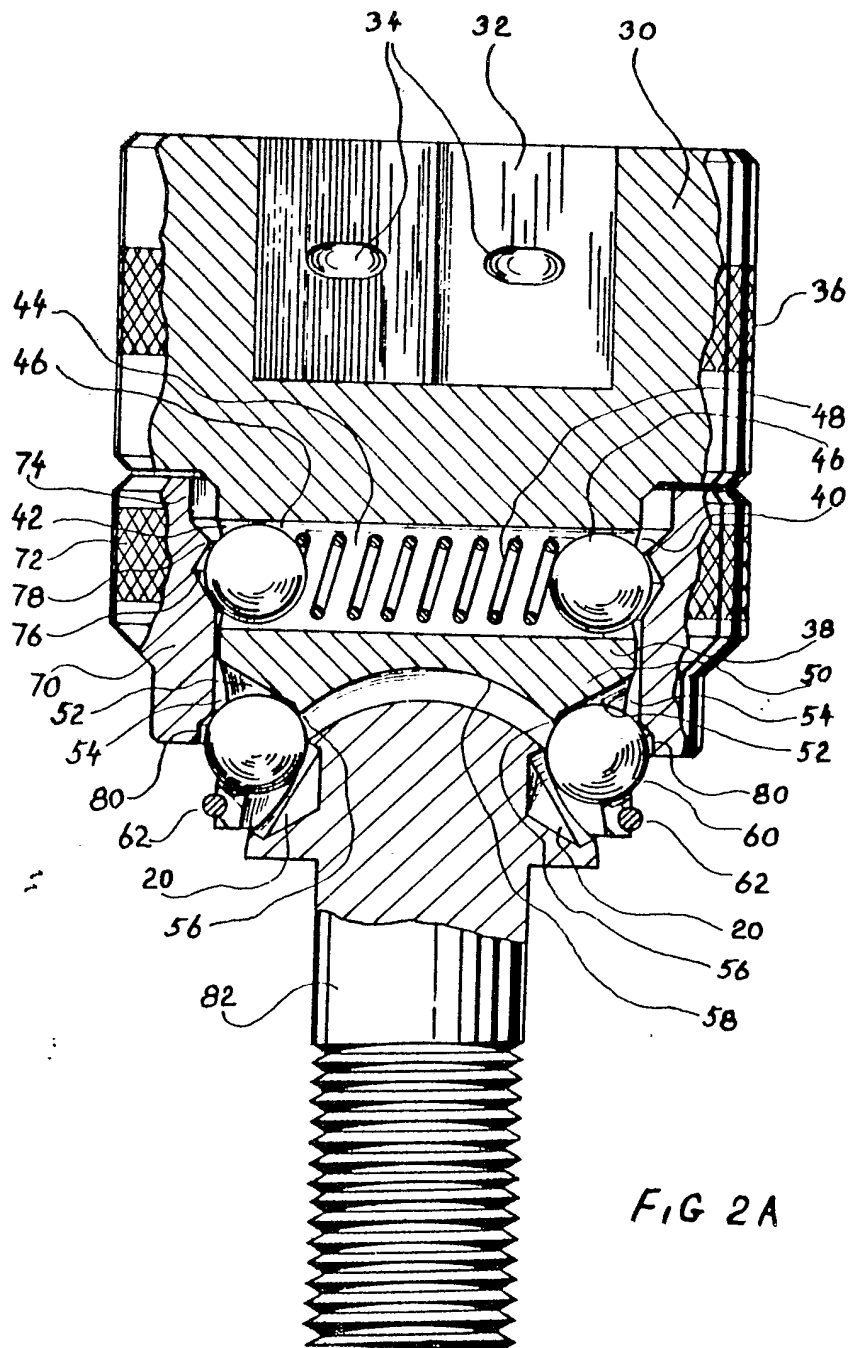


FIG 2A

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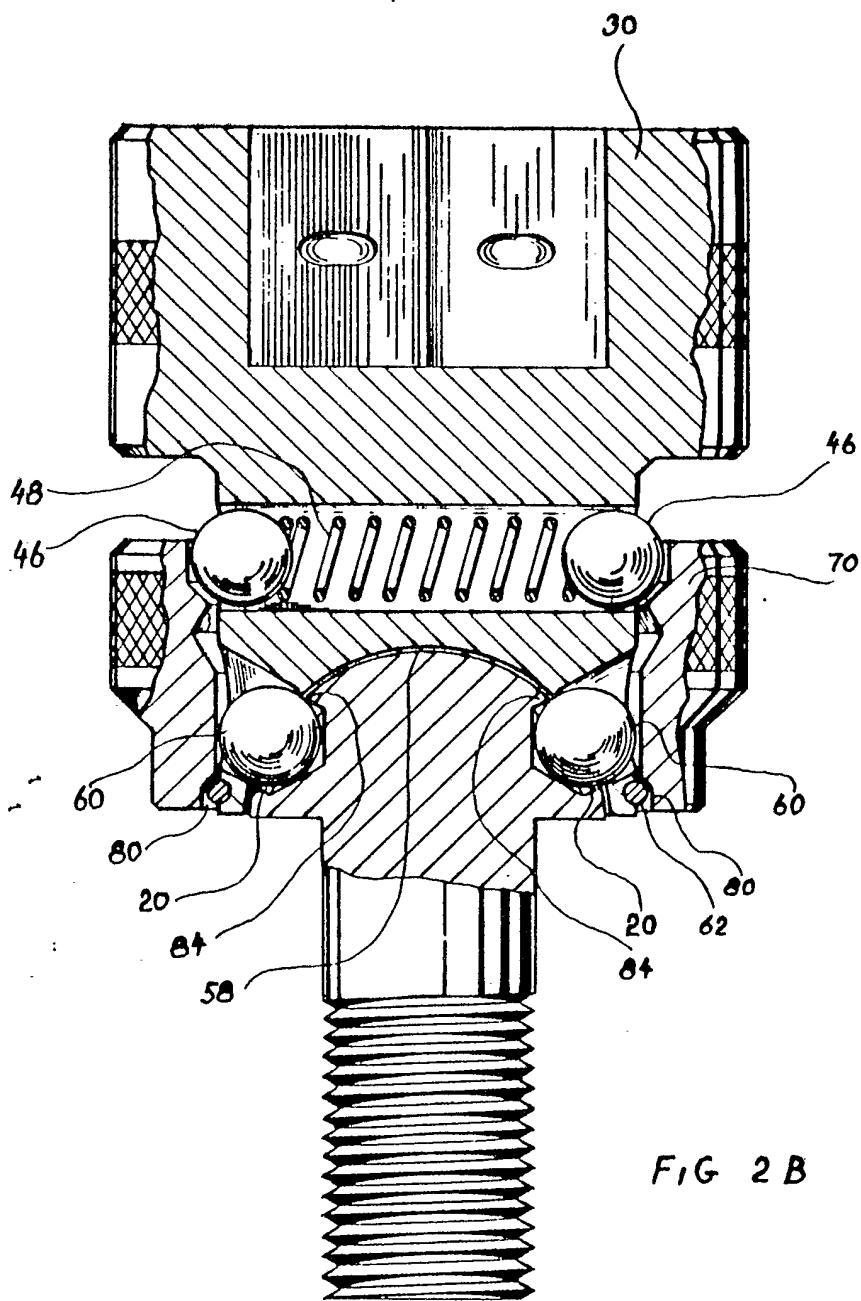
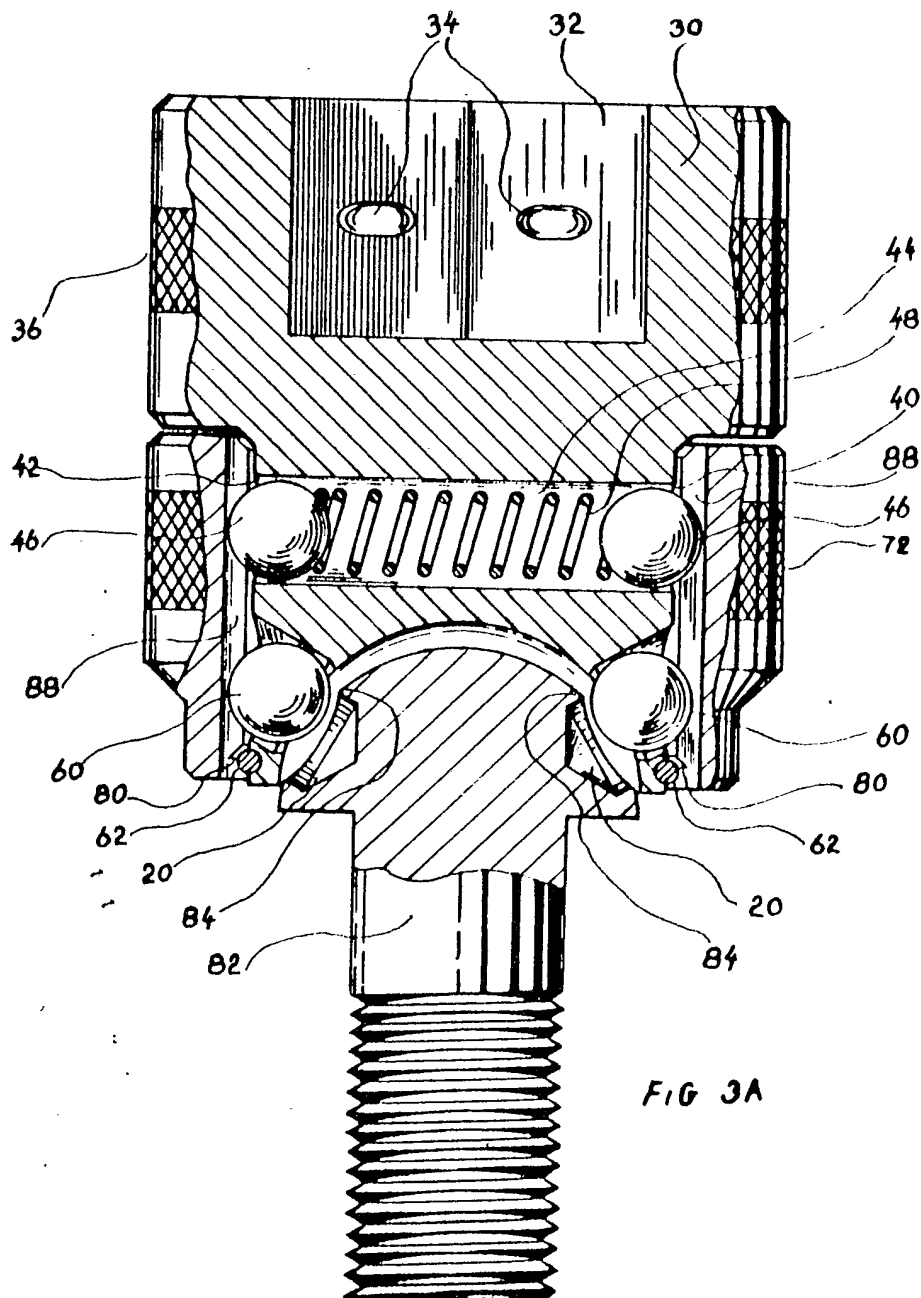
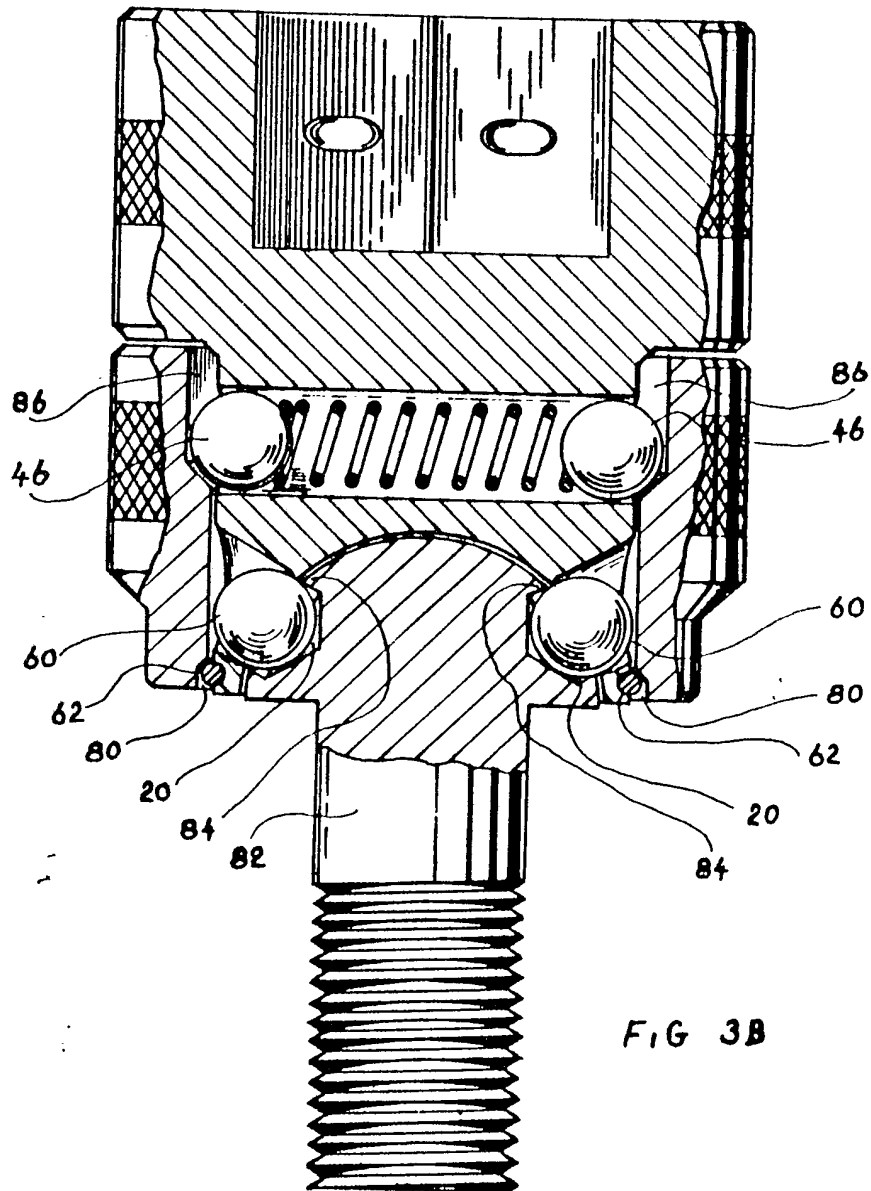


FIG 2 B





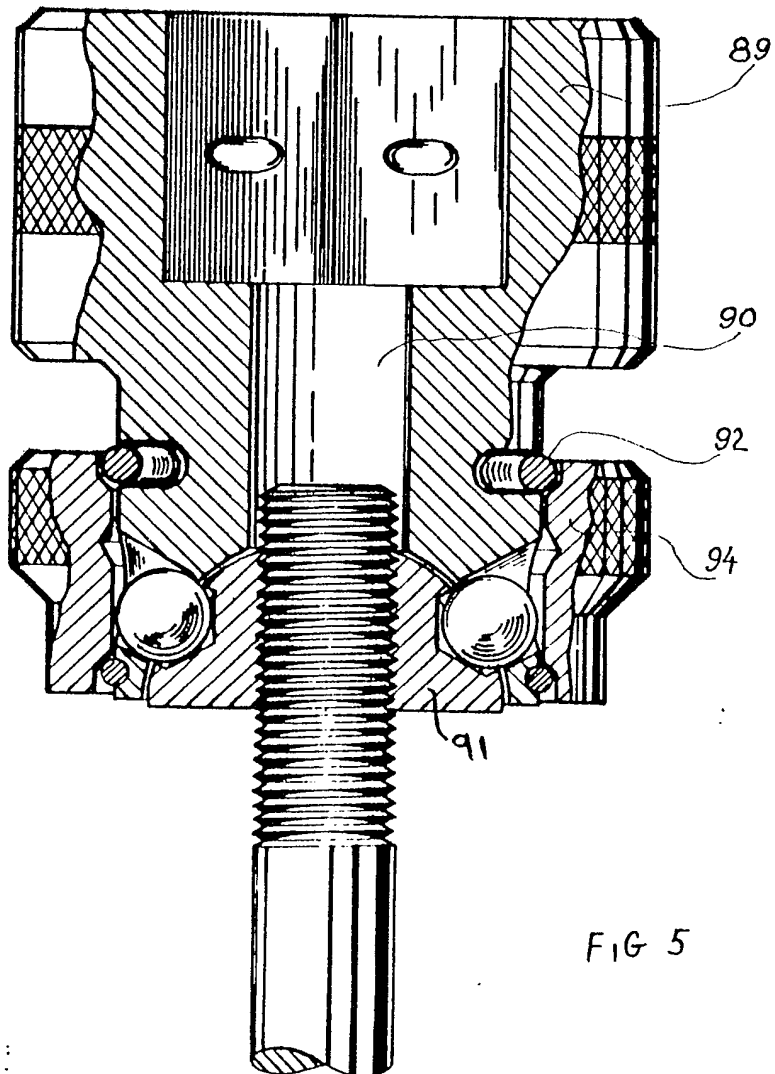
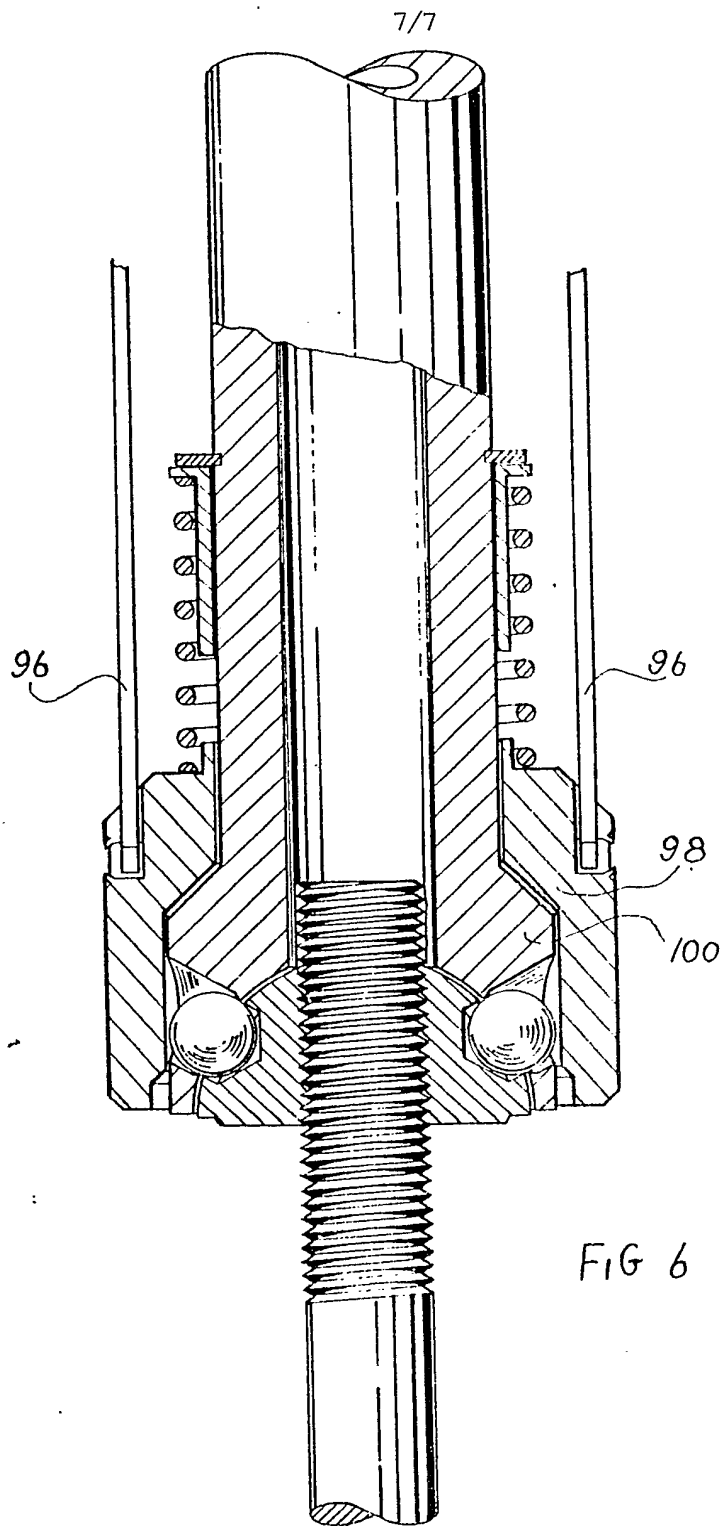


FIG 5

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SPECIFICATION

Security bolt and spanner

5 The present invention relates to fasteners, particularly threaded type fasteners, and special tools for insertion and removal thereof.

Various types of theft resistant fasteners are known in the patent literature and in the marketplace. Examples of such fasteners are described in U.S. Patents 4,170,918; 3,134,291; 3,134,292; 3,482,481 and 3,411,396 and U.K. Patents 1,549,321 and 1,481,442.

15 There are also known in the art various types of wrenches which provide positive holding engagement between the wrench and element such as a bolt, nut, or plug sought to be manipulated thereby. Examples of such wrenches are described in U.S. Patents 20 3,693,484; 3,362,267; 4,187,747; 3,906,822; 3,094,020; 3,354,756. Quick release connectors employing ball and sleeve type securing assemblies are shown, for example, in U.K. Patent 1,558,208 and U.S. Patent 4,198,080.

Nowhere in the prior art available to applicant and set forth hereinabove does there appear the suggestion to provide in the mechanism which produces positive holding engagement between the wrench and the element being manipulated, apparatus which prevents relative rotation between the wrench and the element. The closest approach to this type of structure appears in U.S. Patent 3,693,484 35 wherein a ball and sleeve type coupling is employed to provide positive holding engagement between a wrench and a plug and pins are provided to prevent relative rotation between the wrench and the plug.

The present invention seeks to provide a fastener and a special tool for insertion and removal thereof, the tool being operative to provide ready engagement between the fastener and tool and positive holding engagement both against separation between the tool and the fastener and against relative rotation therebetween.

There is thus provided in accordance with 50 an embodiment of the present invention a fastener comprising a shaft portion having a configuration adapted for rotational engagement with a mating element and a head portion having a plurality of sockets formed therein adapted for engagement by retaining elements 55 associated with a wrench. Additionally in accordance with a preferred embodiment of the present invention, the head is formed with a plurality of sockets of generally circular cross section and oriented at an acute angle relative to a plane perpendicular to the longitudinal axis of the shaft portion.

60 Additionally in accordance with an embodiment of the present invention there is provided a wrench for use with elements having

head portions on which are defined a plurality of sockets, the wrench including a base, a plurality of retaining elements retained in the base and oriented to correspond to the distribution of sockets on the head portions of the elements, and retaining element orienting apparatus operative in a first position to allow the retaining elements to be oriented in a retracted position whereby ready engagement 70 and disengagement of the head portion of an element therewith is permitted and in a second position to secure the retaining elements in an engagement position wherein engagement of the retaining elements in the sockets prevents separation of the head portions from the wrench and relative rotation therebetween.

According to one embodiment of the invention, the orienting apparatus comprises a sleeve which moves axially with respect to the longitudinal axis of a fastener from the first position to the second position. Alternatively, the orienting apparatus comprises a sleeve which moves rotationally from the first position to the second position.

90 According to a preferred embodiment of the present invention, the fastener has a semi-spherical head and is provided with sockets arranged in a single plane, typically oriented about 60° downwards from the longitudinal axis of the fastener. Alternatively, the sockets 95 may be arranged in various planes, have differing separations therebetween and may be of different sizes. The orientation of the sockets may thus define a theft resistant code and require a similarly coded wrench to disengage the fastener.

100 It is a particular feature of the invention that engagement between the fastener and the wrench is not entirely rigid and permits a limited amount of play, which enables ease of fine alignment which is required for efficient fastener attachment.

The present invention will be more fully understood and appreciated from the following detailed description taken in conjunction with the drawings in which:

Figure 1 is a fastener constructed and operative in accordance with an embodiment of the present invention;

115 *Figures 2A and 2B* are illustrations, in partially cut away form, of a wrench element and associated fastener constructed and operative in accordance with a preferred embodiment of the invention in respective disengaged and engaged orientations;

120 *Figures 3A and 3B* are illustrations, in partially cut away form, of a wrench element and associated fastener constructed and operative in accordance with another preferred embodiment of the invention in respective disengaged and engaged orientations;

125 *Figure 4* is a pictorial illustration of a portion of a sleeve employed in the embodiment of Figs. 3A and 3B.

130 *Figure 5* is a partially cut away illustration of

a wrench element constructed and operative in accordance with an alternative embodiment of the invention in engagement association with a nut;

- 5 *Figure 6* is a sectional illustration of a wrench element and associated nut constructed for remote access engagement and disengagement;

- 10 *Figure 7* illustrates a ring used in the embodiment of *Fig. 5*; and

Figure 8 illustrates an alternative fastener socket configuration.

- Reference is now made to *Fig. 1* which illustrates a fastener constructed and operative in accordance with a preferred embodiment of the present invention. The fastener comprises a shaft portion 10, which extends along a longitudinal axis 12 and is typically formed at the lower end thereof with a desired type of threading 14. Integrally formed with shaft portion 10 is a head portion 16. According to a preferred embodiment of the present invention head portion 16 is of overall semispherical configuration defining a disk surface 18 which lies in a plane extending perpendicular to longitudinal axis 12.

- A plurality of sockets 20, in the form of recesses having preferably a circular cross section are arranged in the spherical surface of the head portion 16. Preferably, the sockets 20 are evenly distributed on the spherical surface and lie in a plane parallel to the plane of disk surface 18. According to a preferred embodiment of the invention, the centers of the sockets are oriented at an angle of approximately 60° downwards with respect to the longitudinal axis of the fastener.

- It is appreciated that any desired number of sockets may be employed, although six are preferred in the illustrated embodiment. The size of the fastener and of the head portion as well as of the sockets may also be selected as appropriate. It is also appreciated that the overall configuration of the fastener and its head portion may be selected as appropriate.

- For convenience reference is made throughout the specification and claims to a fastener. Alternatively an element, other than a fastener may be configured with sockets and a head portion of the general type described herein and used with the wrench mechanism to be described hereinbelow. The invention is thus not limited to fasteners, but extends to other types of elements having other or additional functions which render the positive non rotational engagement provided by the invention useful.

- Reference is now made to *Figs. 2A* and *2B* which illustrate a wrench element constructed and operative in accordance with an embodiment of the present invention in association with the fastener of *Fig. 1*. The wrench element comprises a base 30 which is generally configured as a surface of rotation and is

formed with a socket 32 at a first butt end surface thereof for receiving a square head of a conventional standard universal wrench driver, such as a ratchet wrench of conventional construction. Socket 32 is formed with transverse recesses 34 in the walls thereof for accommodating spring loaded balls associated with conventional square heads, which are provided to retain the heads in engagement with the sockets. Alternatively to the provision of socket 32 there may be provided any other type of wrench attachment means or alternatively a wrench handle fixedly attached to base 30 or integrally formed therewith. The portion of base 30 in which socket 32 is defined is typically formed with a conditioned peripheral surface 36 for enhancing the ease of gripping thereof. This portion of base 30, which is of relatively large diameter, will hereinafter be referred to as the grip portion.

- Adjacent the grip portion there is an intermediate portion 38 of lesser diameter than the grip portion. Formed in intermediate portion 38 is a channel 44 formed with apertures 40 and 42. A spring 48 is disposed in channel 44 and is operative to urge balls 46 towards the apertures 40 and 42. It is appreciated that the spring loaded balls 46 operate to selectively retain a sleeve member in one of two selectable positions, as will be described hereinbelow.

- Adjacent intermediate portion 38 of base 30 there is provided a socket defining portion 50 having formed therein a plurality of sockets 52, each defined by a first, large aperture 54 on the radially outer surface of portion 50 and a second smaller aperture 56 on an inner facing surface 58 of portion 50. A ball 60 is disposed in each of sockets 52 and is sized such as to be able to enter through aperture 54 but as to be prevented from passing through aperture 56. A ring 62 is disposed about the bottom edge of portion 50 for defining a stop for axial movement of a sleeve described below.

- It may be appreciated that balls 60 may assume a range of positions extending from a full inward position at which they extend a maximum amount through apertures 56 to a fully retracted position in sockets 52.

- It may be appreciated that the construction described so far is common to both embodiments illustrated in *Figs. 2A*, *2B* and *3A*, *3B*. The structure thus described is indicated by the above reference numerals in both embodiments, for purposes of clarity.

- In the embodiment of *Figs. 2A* and *2B*, there is provided an axially slidable sleeve 70 having a splined or otherwise conditioned gripping surface 72 formed on the outer cylindrical surface thereof and a pair of inner annular shaped recesses 74 and 76, separated by a ring protrusion 78. Sleeve 70 is also formed with a edge shoulder recess 80.

- The operation of the apparatus of *Figs. 2A*

and 2B will now be described briefly. As seen in Fig. 2A, when the sleeve 70 is in its retracted orientation, in abutting relationship to the grip portion of the base 30, balls 46 seat in recess 76 and thus retain the sleeve 70 in its retracted orientation. In this orientation, balls 60 are partially seated in shoulder recess 80 and thus are not pressed to their full inward position. As a result of the freedom of balls 60 in sockets 52, an element, such as fastener 82 having a plurality of sockets 20 may be readily engaged and disengaged from the base 30, since edges 84 of sockets 20 can clear the balls 60.

Turning now to Fig. 2B, which illustrates an engaged orientation of the wrench element, it is seen that the sleeve 70 is in an extended orientation having slid axially relative to base 30 such that balls 46 are seated in recess 74, thus retaining sleeve 70 in its extended orientation. In this orientation sleeve 70 engages balls 60 upwardly of recess 80 and thus forces balls 60 into their full inward position. When the balls 60 are in this position, it can be seen that edges 84 of sockets 20 cannot clear the balls and thus the head portion of the fastener is securely retained against surface 58. It is also appreciated that rotation of the head portion of the fastener with respect to base 30 is impossible due to the discrete, non-continuous configuration of the sockets 20 in the head portion.

Shifting of the sleeve from its extended orientation to its retracted orientation and vice versa is accomplished by axial movement of the sleeve against the spring loaded yieldable force of balls 46.

Reference is now made to Figs. 3A and 3B which illustrate an alternative embodiment of a wrench element. As noted above, the base construction is identical in the two embodiments and is indicated by identical reference numerals. For the sake of conciseness, the description of this portion will not be repeated.

In contrast to the embodiment of Figs. 2A and 2B wherein the engagement status of the wrench element is determined by the axial disposition of the sleeve relative to the base, in the embodiment of Figs. 3A and 3B, the engagement status of the wrench element is determined by the azimuthal disposition of the sleeve relative to the base. In this connection, reference is made particularly to Fig. 4 which illustrates a portion of the sleeve employed in the embodiment of Figs. 3A and 3B. It is seen that the sleeve is formed with alternating half length and full length axial recesses 86 and 88 respectively. Recesses 86 and 88 are ordered and spaced such that they correspond to the spacing of balls 46 whereby the sleeve may be oriented such that both of balls 46 engage either of recesses 86 or 88 in any given orientation.

When the sleeve is oriented so that the

balls 46 engage recesses 88, as seen in Fig. 3A, the balls 60 are not forced into their full inward orientation and thus the fastener may be engaged or disengaged therefrom at will, corresponding to the status shown in Fig. 2A. When the sleeve is rotated from the orientation of Fig. 3A to an orientation as illustrated in Fig. 3B when balls 46 are aligned with recesses 86, the balls 60 are forced inwardly to their full inward orientations, since recesses 86 do not extend fully downward. In this orientation, edges 84 of sockets 20 of the fastener cannot clear balls 60 and the fastener is thus fully retained against surface 58 of the base, similarly to the status of the embodiment shown in Fig. 2B.

It is noted that in both embodiments of the invention, ring 62 prevents disengagement of the sleeve from the base 30.

Reference is now made to Fig. 5 which shows a wrench constructed and operative in accordance with an embodiment of the present invention and which is suitable for use with various types of fasteners including both nuts and bolts. The embodiment of Fig. 5 is similar in most relevant respects to the embodiment illustrated in Figs. 2A and 2B and differs therefrom in that the base, here indicated by reference numeral 89 is provided with an axial bore 90 which is suitable for accommodating the threaded rod portion of a bolt onto which a nut 91 is being fastened.

The provision of bore 90 necessitates the elimination of channel 44 and balls 46 and the replacement thereof by a ring 92 which has a tendency to move outwardly. Typically ring 92, (Fig. 7) is made of spring material and is prestressed so as to push radially outwardly into engagement with sleeve 94 for retention thereof in a desired one of its two operating positions. The remainder of the structure of the wrench is similar to that of the wrench illustrated in Figs. 2A and 2B and its operation is entirely similar.

Reference is now made to Fig. 6 which illustrates a wrench of the type illustrated in Fig. 5 with an additional feature, the provision of elongate actuation rods 96, for providing desired axial motion of the sleeve 98 relative to the base 100. This structure enables engagement and disengagement with a fastener to be provided notwithstanding the inavailability of access of an operator's hand to the location of the fastener. It is appreciated that the elongate actuation rod may be provided also for the embodiment of Figs. 2A and 2B. It is further appreciated that the embodiment of Figs. 5 and 6 may be used for both nuts and bolts without requiring any modification. Means may also be provided to permit remote actuation of the apparatus illustrated in Figs. 3A and 3B.

Reference is now made to Fig. 8 which illustrates an alternative coded type of fastener. In contrast to the fastener illustrated in Fig. 1,

wherein all of the sockets are uniformly spaced in a single plane and are all of the same size, in the embodiment of Fig. 8, it is seen that the size of the sockets may vary from socket, to socket, the spacing between the sockets may vary between adjacent sockets and the various sockets may lie in different planes.

It is appreciated that a theft resistant coding of fasteners may thus be provided by producing fasteners having a socket configuration which requires a specific wrench of corresponding configuration to open the fastener. It is appreciated that one or more of the parameters, such as socket size, spacing and plane orientation may be varied. Other parameters, such as socket configuration may also be varied as required.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined only by the claims which follow:

CLAIMS

1. A fastening system comprising:
a fastener comprising:
a shaft portion having a configuration adapted for rotational engagement with a mating element; and
a head portion having at least three sockets of generally circular cross section formed therein; and
a wrench comprising:
a base;
at least three generally spherical retaining elements disposed in said base and corresponding in their distribution and orientation to the at least three sockets formed on the fastener; and
a retaining element-orienting sleeve defining at least one recess in its interior surface and operative to selectably assume one of first and second positions, in said first position said sleeve being out of radial force engagement relationship with said retaining elements, and in said second position said sleeve surrounding said retaining elements in radial force engagement relationship therewith, said orienting sleeve being operative in said first position to permit said retaining elements to be oriented in a first, retracted orientation wherein said retaining elements are disposed in said recesses and wherein ready engagement and disengagement of the fastener with said base is permitted, and being operative in said second position to orient said retaining elements in a second, extended orientation whereby said fastener is retained in engagement with said base by said retaining elements and rotation between said base and said fastener is prevented.

2. A fastening system according to claim 1 and wherein said head portion is of generally

semispherical configuration.

3. A fastening system according to claim 2 and wherein said plurality of sockets are arranged in a single plane perpendicular to the longitudinal axis of said shaft portion.

4. A fastening system according to claim 3 and wherein the centers of said at least three sockets defined in said head portion are oriented at an angle of approximately 60° downwardly with respect to said longitudinal axis of the fastener.

5. A fastening system according to either of claims 1 and 2, and wherein said plurality of sockets include sockets lying in different planes perpendicular to the longitudinal axis of said shaft portion.

6. A fastening system according to any one of claims 1 to 5, and wherein: said head portion comprises a head portion of generally semispherical configuration defining a diameter extending in a plane perpendicular to the longitudinal axis of said shaft portion; and said at least three sockets are arranged in spaced generally uniform separation on said head portion.

7. A fastening system according to any one of claims 1 to 6, and wherein said shaft portion includes a threaded portion.

8. A fastening system according to any one of claims 1 to 7, and wherein said plurality of sockets include sockets having a plurality of different sizes.

9. A fastening system according to any one of claims 1 to 8, and wherein said plurality of sockets include sockets having a plurality of different spacings therebetween.

10. A fastening system comprising:
a fastener comprising:
a head portion defining a longitudinal axis, rotation about which produces engagement with a mating fastening element; and
at least three sockets of generally circular cross section formed in said head portion along the periphery thereof; and
a wrench comprising:
a base;
at least three generally spherical retaining elements disposed in said base and corresponding in their distribution and orientation to the at least three sockets formed on the fastener; and

a retaining element-orienting sleeve defining at least one recess in its interior surface and operative to selectably assume one of first and second positions, in said first position said sleeve being out of radial force engagement relationship with said retaining elements, and in said second position said sleeve surrounding said retaining elements in radial force engagement relationship therewith, said orienting sleeve being operative in said first position to permit said retaining elements to be oriented in a first, retracted orientation wherein said retaining elements abut against said recesses and wherein ready engagement and di-

sengagement of the fastener with said base is permitted, and being operative in said second position to orient said retaining elements in a second, extended orientation whereby said fastener is retained in engagement with said base by said retaining elements and rotation between said base and said fastener is prevented.

11. A fastening system according to claim 10, and wherein: said head portion is generally semi-spherical; said at least three sockets are arranged in a single plane perpendicular to said longitudinal axis; and said retaining elements comprise retaining balls.

12. A fastening system according to claim 10 and wherein said plurality of sockets includes sockets having a plurality of different sizes.

13. A fastening system according to claim 10, 11 or 12, and wherein said plurality of sockets includes sockets having a plurality of different spacings therebetween.

14. A fastening system according to any one of claims 10 to 13, and wherein said plurality of sockets includes sockets lying in different planes perpendicular to said longitudinal axis.

15. A fastening system according to any one of claims 1 to 14, and wherein said plurality of sockets comprises a coded arrangement of sockets characterised by at least one of the spacing between individual ones of said at least three sockets, the relative location of individual ones of said at least three sockets and the size of individual ones of said at least three sockets, the arrangement requiring said wrench to have a correspondingly coded arrangement of retaining elements for operative engagement therewith.

16. A fastening system according to any one of claims 1 to 15, and wherein said retaining element-orienting sleeve is axially displaceable from said first position to said second position.

17. A fastening system according to any one of claims 1 to 15, and wherein said retaining element-orienting sleeve is rotationally displaceable from said first position to said second position.

18. A fastening system according to any one of claims 1 to 17, and wherein said at least three retaining elements comprise at least three balls.

19. A fastening system according to any one of claims 1 to 18, and further comprising means for selectably retaining said retaining element-orienting means in either of said first and second positions.

20. A fastening system according to any one of claims 1 to 19, and further comprising means coupled to said retaining element-orienting means and permitting remote actuation thereof.

21. A fastening system according to any one of claims 1 to 20, and wherein an elongated bore is formed in said base for accommodating a fastener thread therein.

gate bore is formed in said base for accommodating a fastener thread therein.

22. A fastening system according to claim 11, and wherein said at least three sockets are arranged in a single plane in said head portion perpendicular to the longitudinal axis of the fastener and are oriented with their centers at an angle of approximately 60° downwardly with respect to said longitudinal axis.

23. A fastener comprising:
a shaft portion extending along a longitudinal axis and having a configuration adapted for rotational engagement with a mating element;
a head portion of generally semispherical configuration defining a diameter extending in a plane perpendicular to said longitudinal axis; and
at least three sockets of generally circular cross section formed in said head portion and arranged in spaced generally uniform separation thereon and adapted for selectable engagement by retaining elements associated with a wrench upon said elements being selectably urged into radial force engagement relationship with said sockets;

said fastener being arranged for rotation with said wrench when said sockets are engaged by said retaining elements and for disengagement from said wrench when said sockets are not engaged by said retaining elements.

24. A fastener comprising:
a head portion defining a longitudinal axis, rotation about which produces engagement with a mating fastening element; and
at least three sockets of generally circular cross section formed in said head portion along the periphery thereof and arranged in spaced separation thereon and adapted for selectable engagement by retaining elements associated with a wrench upon said elements being selectably urged into radial force engagement relationship with said sockets;
said fastener being arranged for rotation with said wrench when said sockets are engaged by said retaining elements and for disengagement from said wrench when said sockets are not engaged by said retaining elements.

25. A fastening system substantially as herein described with reference to, and as illustrated in, the accompanying drawings.

26. A fastener substantially as hereinbefore described with reference to, and as illustrated in, Figs. 1, 2a, 2b, 3a, 3b, 5, 6 and 8 of the accompanying drawings.